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COLLEGE OF AGRICULTURE UNIVERSITY OF NEBRASKA
AGRICULTURAL EXPERIMENT STATION
RESEARCH BULLETIN 103

Studies on the Vitamin A Content of Cheese

I. L. Hathaway and H. P. Davis
Department of Dairy Husbandry

LINCOLN, NEBRASKA
JULY, 1938

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SUMMARY

The vitamin-A contents of twenty-two kinds of cheeses were studied by feeding these cheeses to rats whose body stores of vitamin A had been exhausted by being fed a vitamin-A-deficient diet. Twelve experiments were made in which approximately 1100 rats were used. There was considerable variation in the vitamin-A content of the samples studied. The samples of cottage, Neufchatel, and Limburger cheeses had the lowest vitamin-A potency.

Studies on the Vitamin A Content of Cheese

I. L. HATHAWAY AND H. P. DAVIS

Comparatively few studies have been made of the vitamin-A content of cheese. According to some writers (3) there are probably eighteen distinct varieties of cheese although the names of more than four hundred kinds may be found in the literature. Since there are so many kinds, variations may occur in the vitamin-A content of this product.

A number of factors might affect the vitamin-A content of cheese. The vitamin-A potency of the milk from which the cheese was made, the amount of fat in the cheese, the method of processing, the method of packaging, the method of storage, and the organisms used in the manufacturing process may result in products of unequal vitamin-A potency. Since so many factors are involved, the correct vitamin-A value of a given kind of cheese can probably be stated only after a large number of assays have been made. These studies were made, therefore, in order to contribute data which might be used to arrive at the average vitamin-A values of this product.

REVIEW OF LITERATURE

Cook and Axtmayer (1) studied the vitamin-A content of pasteurized milk and whole-milk cheese which were produced in Puerto Rico. The milk was found to contain two units per cubic centimeter and the cheese 20 units per gram (approximately 9,080 units per pound).[1]

Coward and Morgan (2) reported that English Cheddar cheese contained 5,500 International units of vitamin A per 100 grams (approximately 24,970 I. U. per pound).

Morgan (5) studied the vitamin-A content of California cream cheese (Cheddar type), Limburger cheese (from New York), and Swiss cheese (from Switzerland). From this study it was concluded that the California cream cheese and the Limburger cheese retained the vitamin-A content of milk in an unusually concentrated form, since rats fed daily one-half gram portions of these cheeses recovered rapidly from vitamin-A deficiency. Under similar conditions one-gram doses resulted in normal growth but ophthalmia persisted to some extent.

Rice and Munsell (6) reported studies which were made at Columbia University. In these experiments it was found that American cheese, cream cheese, Parmesan cheese, and cottage cheese contained approximately 11,200, 22,400, 11,200, and 480 vitamin-A units per pound respectively.

EXPERIMENTAL PROCEDURES

The breeding stock were pied rats reared in our laboratory. The management of the colony was the same as that outlined in a previous study (4) except where otherwise indicated. The breeding stock was maintained on the Steenbock Stock Ration composed as follows:

[1] In this report no attempt has been made to convert the units reported by various authors to any one particular unit. The approximate relationship, as given by the board of trustees of the U. S. Pharmacopoeia, is as follows: One Sherman unit of vitamin A equals approximately 1.4 International units or 1.4 U. S. P. XI units.

Stock Ration 1

Yellow corn	76.0%	Ground alfalfa	2.0%
Linseed oil meal	16.0%	Sodium chloride	0.5%
Crude casein	5.0%	Calcium carbonate	0.5%

The materials were finely ground and then five per cent by weight of butter was added. In addition to this ration, the rats received fresh whole milk daily and head lettuce several times each week.

The method used for the determination of the vitamin A was essentially the same as the U. S. Pharmacopoeia method for the vitamin-A assay of cod-liver oil (7). Male and female rats, 22 to 25 days old and weighing between 35 and 45 grams, were placed in individual cages which were equipped with false bottoms of 13 millimeter screen. These rats were fed a vitamin-A-free basal ration composed as follows:

Basal Ration 1

Casein [2]	18%	Corn starch	65%
Salt mixture [3]	4%	Vegetable oil [5]	5%
Yeast [4]	8%		

All of the rats received distilled water to which iodine was added once each week. The rats were weighed weekly except near the end of the depletion period, at which time they were weighed daily.

When the rats were depleted (7), after approximately five weeks, they were allotted into groups. As far as possible the litter mates were distributed throughout all of the groups. These groups were fed the vitamin-A-free ration (negative control groups), the cheeses (experimental groups), or U. S. P. reference cod-liver oil (positive control groups) as the cource of vitamin A for eight weeks. The reference oil contained 3,000 U. S. P. XI vitamin-A units per gram and 4.5 milligrams of this oil was fed weekly by means of a pipette to each rat in the positive-control group. The weekly allowance was fed in three doses.

The cheese samples used in the first six experiments, those used in Experiment VIII, and the sample of Edam used in Experiment IX were made in the Nebraska Agricultural Experiment Station creamery. The other samples were purchased locally. The samples were ground in a food chopper, thoroughly mixed, and stored in fruit jars at 0° F. until fed. Once each week a rat's weekly allowance of cheese was weighed into a bottle. This allowance was stored in an electric refrigerator at 38° F. and was fed in three doses during the following week.

Twelve experiments were made in which approximately 1,100 rats were used. The results obtained are shown in Table 1 and the chemical analyses are shown in Table 2. U. S. P. grade oil was used as a supplement to the basal ration in Experiment 1. Since the exact vitamin A potency of this oil was not known the vitamin A potency of the cheese

[2] Purified casein (No. 453) was obtained from the Casein Co. of America, New York City. It was extracted continuously for five days with 95 per cent ethyl alcohol and then heated for five days in an electric oven at 90° C.

[3] Salt mixture No. 2 (7) was used.

[4] Non-irradiated yeast and 30 D yeast (Fleischmann Yeast Co.) were mixed so that each gram of the diet contained 4 U. S. P. XI units of vitamin D.

[5] The vegetable oil was "Primex" manufactured by Proctor and Gamble.

fed in this experiment cannot be estimated. In the other experiments U. S. P. reference cod-liver oil, containing 3,000 units of vitamin A per gram, was used as a supplement to the basal ration. Since the gains made by the groups of rats which were fed the cheeses were not identical with those made by the reference oil groups, the vitamin A potency of the cheeses cannot be stated definitely. The estimated unitage is shown however.

TABLE 1.—*Summary of the average gains in weight of rats fed various cheeses as a source of vitamin A.*

Source of vitamin A	Rats in the group	Av. wt. when feeding source of vitamin A began	Av. wt. at end of experiment	Av. gain	Approximate number of U. S. P. XI units of vitamin A per pound
Grams	*No.*	*Grams*	*Grams*	*Grams*	
		Experiment I			
0.3 Neufchatel	20	103.6	167.1	63.5	....
0.3 Cheddar (Wis. type)	20	107.7	164.3	56.6	....
0.3 Cream	19	107.0	162.2	57.2	....
Positive control [1]	8	94.0	180.1	86.1	....
Negative control [2]	5	87.0	66.2[3]	Died	....
		Experiment II			
0.2 Cheddar (Wis. type)	16	110.1	197.0	86.9	10,896
0.3 Cheddar (Wis. type)	16	105.1	196.1	91.0	....
0.4 Cheddar (Wis. type)	17	116.2	213.1	96.9	....
0.2 Cream	16	107.2	191.0	83.8	10,510
0.3 Cream	18	112.2	202.7	90.5	....
0.4 Cream	18	115.8	209.5	93.7	....
Positive control [4]	10	111.2	151.9	40.7	....
Negative control [2]	16	98.7	69.5[3]	Died	....
		Experiment III			
0.2 Pimento cream	15	98.0	179.0	81.0	7,400
0.4 Pimento cream	15	110.7	213.6	102.9	....
0.2 Neufchatel	12	103.6	160.0	56.4	5,153
0.4 Neufchatel	12	105.1	197.5	92.4	....
0.8 Cottage	9	106.3	145.2	38.9	885
1.0 Cottage	12	104.4	147.6	43.2	...
Positive control [4]	13	95.3	151.1	55.8	...
Negative control [2]	8	86.0	70.7[3]	Died	...
		Experiment IV			
0.15 Olive nut	14	117.1	185.2	68.1	10,472
0.3 Olive nut	12	119.2	207.0	87.8	....
0.15 Relish cream	16	123.5	203.0	79.5	12,227
0.3 Relish cream	14	112.7	212.1	99.4	....
0.1 Cheddar (N. Y. type)	10	109.5	152.5	43.0	9,897
0.2 Cheddar (N. Y. type)	13	113.8	188.9	75.1	....
Positive control [4]	12	112.9	157.1	44.2	....
Negative control [2]	13	105.3	79.7[3]	Died	....

[1] U. S. P. grade cod-liver oil was the source of vitamin A.
[2] The negative controls received only the vitamin-A-free diet.
[3] Average weight of the rats at death.
[4] U. S. P. reference cod-liver oil (2.25 units) was the source of vitamin A.

TABLE 1.—*Summary of the average gains in weight of rats fed various cheeses as a source of vitamin A.—(Continued)*

Source of vitamin A	Rats in the group	Av. wt. when feeding source of vitamin A began	Av. wt. at end of experiment	Av. gain	Approximate number of U. S. P. XI units of vitamin A per pound
Grams	*No.*	*Grams*	*Grams*	*Grams*	
		Experiment V			
0.6 Cottage	15	123.1	201.8	78.7	3,306
0.8 Cottage	15	116.6	216.6	100.0	....
0.1 Cheddar (Wis. type)	8	130.1	162.7	32.6	8,217
0.15 Cheddar (Wis. type)	14	113.3	176.2	62.9	....
0.1 Pimento cream	14	111.0	187.6	76.6	19,295
0.15 Pimento cream	15	113.4	205.6	92.2	....
Positive control [4]	9	113.1	153.6	40.5	....
Negative control [2]	9	107.1	79.5[3]	Died	....
		Experiment VI			
0.4 Cottage	6	116.1	144.8	28.7	2,156
0.1 Neufchatel	8	112.1	145.2	33.1	9,942
0.1 Cream	6	117.1	149.0	31.9	9,579
0.09 Olive nut	7	126.8	155.5	28.7	9,584
0.075 Pimento cream	7	129.8	172.1	42.3	16,949
0.075 Relish cream	10	121.5	163.2	41.7	16,707
Positive control [4]	6	115.1	149.0	33.9	....
Negative control [2]	7	106.8	78.8[3]	Died	....
		Experiment VII			
0.08 Roquefort	11	92.8	142.8	50.0	18,216
0.1 Roquefort	7	97.5	161.8	64.3	....
0.15 Roquefort	10	93.0	168.5	75.5	....
0.08 Camembert	10	100.5	145.6	45.1	16,400
0.1 Camembert	8	98.0	153.5	55.5	....
0.15 Camembert	11	101.2	180.0	78.8	....
0.08 Liederkranz	9	101.4	144.3	42.9	15,606
0.1 Liederkranz	8	94.3	149.6	55.3	....
0.15 Liederkranz	11	98.4	171.6	73.2	....
Positive control [4]	4	93.5	128.5	35.0	....
Negative conrtol [2]	8	93.7	71.6[3]	Died	....
		Experiment VIII			
0.4 Cottage	5	121.6	135.0	13.4	....
0.7 Cottage	10	116.4	151.7	35.3	856
1.0 Cottage	9	109.4	169.8	60.4	....
0.08 Canned Cheddar	10	119.7	152.8	33.1	7,037
0.10 Canned Cheddar	7	110.0	157.7	47.7	....
0.15 Canned Cheddar	12	113.1	180.0	66.9	....
0.08 Neufchatel	9	113.8	133.7	19.8	....
0.1 Neufchatel	11	111.5	142.4	30.9	5,266
0.15 Neufchatel	11	112.8	164.4	51.6	....
Positive control [4]	10	116.7	176.5	59.8	....
Negative control [2]	6	97.3	73.6[3]	Died	....

TABLE 1.—*Summary of the average gains in weight of rats fed various cheese as a source of vitamin A.—(Concluded)*

Source of vitamin A	Rats in the group	Av. wt. when feeding source of vitamin A began	Av. wt. at end of experiment	Av. gain	Approximate number of U. S. P. XI units of vitamin A per pound
Grams	*No.*	*Grams*	*Grams*	*Grams*	
		Experiment IX			
0.1 Limburger	15	112.0	149.7	37.6	5,811
0.15 Limburger	16	114.6	177.4	62.7	....
0.1 Danish brick	15	113.8	184.2	70.4	10,896
0.15 Danish brick	14	111.7	195.3	83.5	....
0.1 Edam	8	113.6	140.8	27.2	....
0.15 Edam	11	116.0	164.8	48.7	5,024
Positive control [4]	10	114.6	180.6	66.0	....
Negative control [2]	8	102.6	73.2[3]	Died	....
		Experiment X			
0.1 Edam	11	128.5	177.4	48.9	11,213
0.15 Edam	11	123.9	184.5	60.6	....
0.1 Danish Blue	11	127.0	196.8	69.7	15,980
0.15 Danish Blue	12	127.0	217.0	90.0	....
0.1 Chantelle	11	120.0	157.8	37.8	8,671
0.15 Chantelle	12	126.5	196.9	70.3	....
Positive control [4]	12	128.3	172.8	44.5	....
Negative control [2]	7	136.5	91.5[3]	Died	....
		Experiment XI			
0.1 Kraft pimento	13	125.6	179.0	53.3	10,714
0.15 Kraft pimento	14	132.2	203.0	70.8	....
0.1 Kraft American	13	123.6	172.4	48.7	9,806
0.15 Kraft American	12	130.6	177.9	47.2	....
0.1 Kraft brick	13	129.9	152.0	22.0	....
0.15 Kraft brick	12	121.7	169.5	47.7	6,386
Positive control [4]	13	129.0	179.7	50.7	....
Negative control [2]	7	144.0	103.4[3]	Died	....
		Experiment XII			
0.1 Kraft Limburger	13	121.4	153.6	32.2	6,628
0.15 Kraft Limburger	15	125.8	175.9	50.1	....
0.1 Kraft Creamed Old English	15	126.4	194.2	67.8	13,937
0.15 Kraft Creamed Old English	15	123.9	204.7	80.8	....
0.1 Kraft Swiss	14	125.6	169.2	43.6	8,943
0.15 Kraft Swiss	15	129.5	185.6	56.1	....
Positive control [4]	11	126.0	175.6	49.6	....
Negative control [2]	14	135.0	80.8[3]	Died	....

TABLE 2.—*Chemical analyses in percentage of the cheeses used in the various experiments.*

Kind of cheese	Acid[1]	Protein	Fat	Moisture	Ash	Sugar[2]
		Experiment I				
Neufchatel	...	...	20.02	62.82	...	...
Cheddar (Wis. type)	...	...	31.09	38.04	...	...
Cream	...	...	30.70	53.72	...	...
		Experiment II				
Cheddar (Wis. type)	0.38	28.23	31.19	24.25	4.28	2.05
Cream	1.67	9.41	34.29	52.12	1.67	2.41
		Experiment III				
Pimento cream	0.32	13.89	17.60	65.04	1.61	1.85
Neufchatel	0.33	11.19	19.04	66.10	0.66	2.99
Cottage	0.18	14.44	2.94	79.99	1.07	1.55
		Experiment IV				
Olive nut	...	...	35.37	53.24	...	...
Relish cream	...	...	18.12	67.39	...	...
Cheddar (N. Y. type)	...	...	31.47	56.43	...	...
		Experiment V				
Cottage	0.20	13.07	5.44	78.29	1.12	2.08
Cheddar (Wis. type)	0.69	26.95	29.88	35.65	4.06	3.46
Pimento cream	0.26	13.86	18.42	62.51	1.54	3.66
		Experiment VI				
Cottage	0.14	13.33	4.49	79.39	1.01	1.76
Neufchatel	0.28	10.30	19.85	63.08	1.91	4.85
Cream	0.30	6.37	24.15	60.58	1.71	6.18
Olive nut	0.25	6.28	25.53	58.06	2.02	8.11
Pimento cream	0.31	13.51	15.94	63.15	1.61	5.77
Relish cream	0.48	8.97	18.10	61.54	1.63	10.26
		Experiment VII				
Roquefort	1.69	27.51	29.38	36.37	5.59	1.15
Camembert	1.10	17.78	22.18	55.44	3.44	1.14
Liederkranz	0.985	18.24	25.12	55.06	2.91	...
		Experiment VIII				
Cottage	0.15	12.53	4.29	78.32	1.30	3.56
Cheddar (canned)	1.08	25.62	27.29	39.14	3.40	4.55
Neufchatel	0.32	12.07	17.68	63.29	1.65	5.31
		Experiment IX				
Limburger	0.88	23.06	28.85	44.77	3.63	...
Danish brick	0.61	24.08	31.06	38.31	3.22	3.32
Edam	0.90	28.23	32.23	32.00	5.35	2.18
		Experiment X				
Commercial Edam	0.84	30.86	25.57	36.24	6.20	1.11
Danish Blue	1.37	23.49	32.77	35.78	6.52	1.44
Chantelle	0.61	24.86	29.05	39.65	3.89	2.54
		Experiment XI				
Kraft pimento	0.82	23.34	28.71	39.76	4.98	3.21
Kraft American	0.71	23.38	29.46	39.48	4.85	2.82
Kraft brick	0.70	21.38	27.58	41.81	5.54	3.68
		Experiment XII				
Kraft Limburger	0.61	15.97	21.34	56.58	4.19	1.91
Kraft Creamed Old English	1.00	19.08	32.09	*41.45*	*3.31*	*4.06*
Kraft Swiss	1.06	26.25	25.81	39.84	5.24	2.85

[1] Calculated as lactic acid.
[2] Calculated as lactose.

From these data it was estimated that a pound of each of these cheeses contained the following number of units of vitamin A:

	Units		*Units*
Cheddar (N. Y. type)	9,897	Chantelle	8,671
Roquefort	18,216	Limburger	5,811
Camembert	16,400	Kraft pimento	10,714
Liederkranz	15,606	Kraft American	9,806
Cheddar (canned)	7,037	Kraft brick	6,386
Danish brick	10,896	Kraft Creamed Old English	13,937
Edam (made in Station creamery)	5,024	Kraft Swiss	8,943
Edam (purchased)	11,213	Kraft Limburger	6,628
Danish Blue	15,900		

In several instances different samples of a given kind of cheese were fed in different experiments and the following vitamin A values were obtained:

	Units
Cheddar (Wis. type)	10,896 and 8,217
Cream	10,510 and 9,579
Olive nut	10,472 and 9,584
Relish cream	12,227 and 16,707
Cottage	885, 3,306, 2,156 and 856
Neufchatel	5,153, 9,942 and 5,266
Pimento cream	7,400, 19,295 and 16,949

These data probably are not extensive enough to establish definitely the average vitamin-A content of a given kind of cheese. A large number of samples would have to be assayed in order to establish the exact vitamin-A potency. It seems evident, however, that there is considerable variability in the vitamin-A content of this product. Furthermore, the vitamin-A potency of a given kind of cheese may vary with different samples. From the chemical analysis which was made of these samples, it is evident that the vitamin-A potency does not strictly parallel the fat content. In general the samples of cottage, Neufchatel, and Limburger cheeses had the lowest vitamin-A potency.

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